cells. The assay flow cell comprises a chamber having a fluid inlet and fluid outlet and a flow path between the inlet and outlet. An array of electrodes is patterned on an internal surface of the chamber. When used in electrode induced luminescence assays, the internal chamber surface opposing the electrode array is, preferably, light-transmissive so as to allow for the detection of light generated at the electrodes. One or more of the electrodes comprise assay reagents immobilized on the electrode. These assay domains are used to carry out assay reactions which are detected by using the electrode to induce an assay dependent signal such as an electrochemical or, more preferably, an electrode induced luminescence signal and detecting the signal. Preferably, these assay reagents are arranged in one or more assay domains defined by apertures in a dielectric layer deposited on the electrode. Optionally, the fluid inlet comprises a fluid inlet line that has sensors for detecting the presence of fluid in the fluid inlet line.

[**0098**] Preferably, the electrodes in the assay cartridge are patterned in a one dimensional array along the fluid path. The array and or fluid path are, preferably, in a linear arrangement, although other shapes (e.g., arcs, curves, zigzags, etc. may also be used). In such a configuration, it is advantageous for the active area of the electrodes and aspect ratio of the flow path be selected to ensure that assay domains on the electrode efficiently sample analytes in fluids passing through the flow cell. Most preferably, the length of the flow path along the direction of flow is greater than the width perpendicular to the direction of flow, the active area of the electrode takes up a significant portion of the width of the flow path (preferably greater than 60%, more preferably greater than 80%), and/or the height of the flow path above the electrodes is small compared to the width of the flow path. Surprisingly, it has been found that the surface area of dedicated counter electrodes in the flow cell can be reduced significantly without affecting assay performance by reusing electrodes used as working electrodes (e.g., working electrodes having binding domains used for electrode induced luminescence assays), these electrodes being reused as counter electrodes for measuring an assay dependent signal from another, preferably adjacent, working electrode. In an especially preferred embodiment, the electrodes are activated in a pair-wise fashion along the path of the flow cell, the interior electrodes in the one-dimensional electrode array being used as working electrodes for inducing an assay dependent signal and subsequently as counter electrodes for inducing an assay dependent signal at an adjacent electrode.

[**0099**] The assay cartridges of the invention may comprise a plurality of flow cells or detection chambers. In certain preferred embodiments the flow cell may comprise the same assay domains or, at least, have at least some assay domains that share specificity for the same analytes of interest. In these embodiments, the plurality of flow cells may be used to analyze a plurality of different samples or to compare samples that have been pre-treated in different ways. Alternatively, one of the flow cells may be a control flow cell used to analyze a control sample and another of the flow cells may be a test flow cell used to analyze a test sample. The control sample may be a completely pre-defined control sample or may be a mixture comprising the test sample but spiked with added analytes of interest so as to allow for calibration of the assays by the method of standard addition. In an alternative embodiment, the assay cartridge has at least two flow cells that have assay domains for two different assay panels. Advantageously, such a cartridge may be used to separately perform assay reactions that are incompatible with each other.

[**0100**] **FIG. 1 a** depicts a simplified schematic of a cartridge-based biochemical detection system **100** in accordance with one embodiment of the invention. Preferably a system housing, e.g., cartridge reader **105**, would include an optical detector **110** and would be adapted and configured to receive and position cartridge **115** and/or optical detector **110** for processing. The system would preferably contain support subsystems (not shown) that may include one or more of the following: storage subsystem for storing assay reagents/consumables and/or waste; sample acquisition/preprocessing/storage subsystem for sample handling; fluidic handling subsystem for handling the reagents, sample, waste, etc. and for providing fluids to the detection chamber **120** via a fluid inlet line **125**; electrical subsystem for electrically contacting the cartridge's electrical contacts **130** and supplying electrical energy to the electrodes **135,136, 137**; and a control subsystem for controlling and coordinating operation of the system and subsystems and for acquiring, processing and storing the optical detection signal.

[**0101**] As illustrated, one preferred embodiment would use an electrode array that preferably has at least one dedicated counter electrode **135**, one dual-role electrode **136** and one dedicated working electrode **137**. Such a preferred configuration would use a pair-wise firing scheme (discussed in detail below) wherein the dual-role electrode can be reused. **FIG. 1***b* depicts in greater detail one possible embodiment for the detection portion of a cartridge-based device **150**. As depicted, two detection chambers **155,156** each contain a bank of nine individually addressable electrodes **157,158**. There are two fluid input lines depicted **160,161** for introducing sample, reagents and/or wash solutions into the detection chambers and two banks of electrical contacts **165,166** with corresponding electrical leads **170, 171** to the electrodes **157,158**. Also depicted in this preferred embodiment are two banks of impedance sensors **172,173** that may be used fluid detection (e.g., sample, reagents, wash, buffer, etc.) and/or fluid discrimination (e.g., discriminating between sample, reagents, wash, buffer, etc. and/or sample type such as whole blood, plasma, mucous, etc.).

[**0102**] **FIG. 1***c* is an assembly schematic for one preferred embodiment illustrating the assembly of cartridge component **178** comprising an electrode array **176**. According to one embodiment, electrode array **176** (preferably, comprised of carbon ink) is applied to the substrate layer **175** forming the electrode **180**, electrical lead **181** and electrical contact **182** portions. A dielectric layer **177** is preferably applied over the electrode layer to define the assay domains **190** and the impedance sensors **191**. Alternately, electrical contacts **182** could be printed on the opposing side of the substrate and connected to electrodes **180** or electrical leads **181** via conductive through-holes through the substrate. Methods for applying the carbon and dielectric layers as well as various alternative materials are discussed below in greater detail.

[**0103**] Cartridge component **178** is, preferably, mated with a second cartridge component. The second cartridge component has channels or apertures arranged on the mating surface so that when mated to cartridge component **178** it acts to form detection chambers over the electrode arrays (e.g., as illustrated by detection chambers **155** and **156** in